CORE COURSES OFFERED BY DEPT. OF MATHEMATICS

BMA23209T	MECHANICS	L	T	P	C
		3	1	0	4

Pre-requisite: Knowledge of Mathematics at Class XI & XII

Course Objectives:

- To train students he fundamental concept on mechanical systems in equilibrium
- To introduce the concept of forces act on objects at rest (statics) and in motion (dynamics)

Course Outcome:

After successful completion of the course, the students will be able to

CO1: understand and identify forces and their resultants
CO2: recognize and classify moments and couples created by forces
CO3: understand the basic concepts such as velocity, acceleration, force, momentum, work and energy
CO4: understand an apply the laws related to planetary motion
CO5: understand the concept of rigid body motion

Module 1: Statics	**15 Hours**

Concurrent Forces, Lami's Theorem, Resultant force and resultant couple, Coplanar forces, Equilibrium of a particle and of coplanar forces, Laws of friction, Virtual Work, Centre of gravity

Module 2: Dynamics of a Particle	**15 Hours**

Velocity, acceleration, angular velocity, linear and angular momentum, Velocity and acceleration for Cartesian and polar coordinates, tangential and normal components.

Module 3: Central Forces and Planetary Motion	**15 Hours**

Central forces, Properties of central force fields, Motion under central force fields, Potential energy, Conservation of energy, Newton's law on gravitation, Kepler's laws of planetary motion, Motion under inverse square law

Module 4: Dynamics of Rigid Bodies	**15 Hours**

Moment of Inertia, Product of Inertia, Momental ellipsoid, D'Alembert's principle, Conservation of momentum and energy

Total Lecture hours	**60 Hours**

Text Book(s)

1. Ramsey A. S., Statics, (Ebook) The University Press, Cambridge, 1945
2. Das B.C. & Mukherjee B. N., Statics, U. N. Dhur & Sons Pvt. Ltd, 2018
3. Loney S.L., An elementary treatise on the dynamics of a particle and of rigid bodies, Cambridge : University Press, 1913

Reference Books

1. Chorlton, F., Textbook of Dynamics, CBS, Publications 2nd Edition,1985
2. Spiegel M.R., Theoretical Mechanics, Schaum Series, 2010

CORE COURSES OFFERED BY DEPT. OF MATHEMATICS

		L	T	P	C
BMA23301T	**REAL ANALYSIS II AND METRIC SPACES**	**3**	**1**	**0**	**4**

Pre-requisites: Real Analysis

Course Objectives:

- To give students idea continuity and differentiability theorems in real functions
- To provide a detailed idea of Riemann Integrals
- To give students idea of Metric Spaces.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: demonstrate continuity and differentiability of real functions.
CO2: apply the concepts of Riemann Integral to evaluate specific integrals.
CO3: interpret the definitions of limit points, interior and boundaries points, and explain their relevance in metric spaces.
CO4: demonstrate continuity, uniform continuity and connectedness in metric spaces.

Module1:	**15Hours**

Continuity of a function, sequential criterion, algebra and composition of continuous functions. Continuous functions on intervals, maximum-minimum theorem, location of roots and Bolzano's intermediate value theorem. Uniformly continuity. Lipshitz function. Continuous extension theorem. Differentiability, Rolle's Theorem, Mean value theorems and applications, Taylor's theorem, Expansion of functions by Maclaurin's theorem.

Module2:	**15Hours**

Definition of Riemann integral using upper and lower Darboux sums; Definition of Riemann integration using Riemann sums; equivalence of the two definitions; Riemann integrability of monotone and continuous functions; Properties of the Riemann integral; Definition and integrability of piecewise continuous functions; Intermediate value theorem for integrals; Fundamental theorems of calculus.

Module3:	**15Hours**

Definition and examples of metric spaces, Open ball, Neighborhoods, Limit points, Interior and boundary points, Open and closed sets, Closure and interior of a set, Equivalent metrics. Subspaces, Cauchy sequences, Completeness, Cantor's intersection theorem, Baire's category theorem.

Module4:	**15Hours**

Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach contraction mapping principle. Connectedness, connected subsets of R, connectedness and continuous mappings.

Total Lecture hours	**60hours**

Text Book(s)

1. A. Kumar and S. Kumaresan, Basic Course in Real Analysis, CRC Press, 2014.
2. S. C Malik, Savita Arora, Mathematical Analysis, New Age Publishers.
3. O'Searcoid, M. Metric Spaces, Springer, 2007
4. Metric Space, P K Jain, Khalil Ahmed, Narosa Publishing House.

Reference Books

1. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore,2002.
2. SaminathanPonnusamy, Foundations of mathematical analysis. Springer Science & Business Media, 2011.
3. Simmons, G. F. Introduction to Topology and Modern Analysis. Mc-Graw Hill Education, 2017.

CORE COURSES OFFERED BY DEPT. OF MATHEMATICS

BMA23302T	LINEAR ALGEBRA	L	T	P	C
		3	1	0	4

Pre-requisite: Knowledge of Mathematics at Class XI & XII, Algebra and Calculus I

Course Objectives:

- To introduce the students to the fundamental concepts and topics of linear algebra
- To demonstrate the students various application of techniques using the adjoint of a linear operator and their properties to least squares approximation.
- To apply linear algebra to solve problems in sub-disciplines of computer science.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: apply operations on matrices and sparse matrices.

CO 2: compute the dimension of a vector space.

CO3: evaluate the determinant, rank and eigen values and eigen vectors of a matrix.

CO4: attain a basic idea about Inner product spaces, orthogonal and orthonormal vectors.

Module1:Introduction to Vector Space	**15Hours**

Vector Space, Sub-spaces, Linear Combinations, Linear Span, Convex Sets, Linear Independence/Dependence, Basis & Dimension.

Module2:Linear Transformation	**20Hours**

Linear transformation on finite dimensional vector spaces, Kernel and Rank of a vector space, Rank Nullity Theorem, Types of Linear mapping, Linear mapping and Matrices. Change of Basis

Module3: Eigen Values and Eigen Vectors	**10Hours**

Eigenvectors and eigenvalues of a matrix, the characteristic equation, diagonalization, eigenvectors of a linear transformation, complex eigenvalues, Invariant subspaces and Cayley-Hamilton theorem.

Module4: Inner Product Space	**15Hours**

Inner product, length, and orthogonality, orthogonal sets, orthogonal projections, Schwarz Inequality, Orthonormal Basis, the Gram-Schmidt Orthogonalization Process., inner product spaces; Diagonalization of symmetric matrices, the Spectral Theorem

Total Lecture hours	**60hours**

Text Book(s)

1. Lipschutz S. and Lipson M., *Schaum's Outline of Linear Algebra*, 6th Edition, McGraw Hill, 2017.

Reference Books

1. Kumaresan S., *Linear Algebra- A Geometric Approach*, Prentice Hall of India,1999.
2. Saikia, P. K., *Linear Algebra*, Pearson Education India, 2009.
3. Kenneth H., Ray A. K., *Linear Algebra*, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.

CORE COURSES OFFERED BY DEPT. OF MATHEMATICS

MMA23602T	NUMERICAL ANALYSIS	L	T	P	C
		4	0	0	4

Pre-requisite: Calculus and Differential Equations

Course Objectives:

- To learn well-known numerical techniques to solve physical problems and evaluate the results
- To introduce the basic concepts of solving algebraic, transcendental equations and system of linear and non-linear equations.
- To understand numerical solution of ordinary differential equations.

Course Outcome:

After successful completion of the course, the students will be able to

CO 1: apply numerical methods to obtain approximate solutions to mathematical problems
CO2: find roots of linear and non-linear system (algebraic and transcendental) of equations
CO3: solve ordinary differential equations numerically.

Module 1: Solution of Algebraic and Transcendental Equations	**30 Hours**

Bisection method- Secant Method, Regula Falsi Method, Newton-Raphson method, Muller's method, Direct methods for solving systems of linear equations: Matrix inversion methods, Gauss Elimination method, Gauss-Jordan method, LU decomposition; Iterative methods: Jacobi's method, Gauss-Seidel method, Relaxation Methods

Module 2: Solution of Ordinary Differential Equations	**30 Hours**

Solution of differential equations: Picard's method, Taylor's series method, Euler's method, Modified Euler's method, Runge-kutta method, Predictor-corrector method, Milne's method, Boundary value Problems, Shooting method

Total Lecture hours	**60 Hours**

Text Book(s)

1. K. E. Atkinson, *An Introduction to Numerical Analysis*, John Wiley and Sons, 1989
2. C. F. Gerald and P. O. Wheatley, *Applied Numerical Analysis*, Pearson, 7th Edition, 2004
3. M.K. Jain, S. R. K. Iyengar, R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, New Age International, 2005

Reference Books

1. Niyogi P., *Numerical Analysis and Algorithm*, Tata Mcgraw Hill
2. S. D. Conte and DeBoor C., *Elementary Numerical Analysis: An Algorithmic Approach*, McGraw Hill, N.Y., 1980.

CORE COURSES OFFERED BY DEPT. OF MATHEMATICS

BMA23321T	R Programming	L	T	P	C
		2	0	4	4

Pre-requisite: Knowledge of Complex Functions and derivatives

Course Objectives:

- To give students idea of integration over a complex plane, power series expansion and convergence of infinite sequences and series.
- To provide a detailed study of residues, its uses in evaluating integrals.
- To give students idea about conformal mapping, different types of transformations.

Course Outcome:

After successful completion of the course, the students will be able to
CO1: demonstrate basic data structures in R.
CO2: illustrate functions, Control structures like if, while, and for allow to control the flow of an R program
CO3: apply loop functions which allow conduct a series of operations on data using a compact form.
CO4: demonstrate simulation of linear models, random sampling using R

Module1: — **15Hours**

Introduction to R, Getting help with functions and features, R interpreter, Introduction to major R data structures like vectors, matrices, arrays, list and data frames, Control Structures, vectorized if and multiple selection.

Module2: — **15Hours**

Control Structures, Functions, Scoping Rules, Coding Standards.

Module3: — **15Hours**

Loop functions: lapply, tapply, split, mapply, apply, Splitting a Data Frame; Vectorizing a Function, Debugging Tools, Simulation: Generating Random Numbers, Simulating a Linear Model, Random Sampling, R Profiler.

Practical / Lab work to be performed — **15Hours**

1. Write a program that prints “Hello World” to the screen.
2. Write a program that asks the user for a number n and prints the sum of the numbers 1 to n
3. Write a program that prints a multiplication table for numbers up to 12.
4. Write a function that returns the largest element in a list.
5. Write a function that computes the running total of a list.
6. Write a function that tests whether a string is a palindrome or not.
7. Implement the sorting algorithms: Selection sort, Insertion sort, Bubble Sort
8. Implement linear search and binary search algorithm.

10. Implement matrices addition, subtraction and multiplication

Total Lecture hours — **60 hours**

Text Book(s)

1. Venables W. N. and Smith D. M., An Introduction to R. 2nd Edition (online)
2. Peng, R. D., R programming for data science, Victoria, BC, Canada: Leanpub, 2016. https://bookdown.org/rdpeng/rprogdatascience/

Reference Books

1. Cotton, R., Learning R: a step by step function guide to data analysis. 1st edition. O’reilly Media Inc, 2013
2. Gardener, M., Beginning R: The statistical programming language, WILEY, 2017

CORE COURSES OFFERED BY DEPT. OF MATHEMATICS

BMA23322T	OPERATION RESEARCH	L	T	P	C
		3	1	0	4

Pre-requisites: Knowledge of Mathematics at Class XI & XII

Course Objectives:

- To enable students to formulate any practical problem as a linear programming problem.
- To enable students to solve linear programming problems using different techniques.
- To make students understand the concept of optimality.

CourseOutcome:

Aftersuccessfulcompletionofthe course,the studentswillbe ableto
CO1: understand the difference between a solution and an optimal solution.
CO 2:apply the concept of LPP to formulate and solve a practical problem.
CO 3: analyze the optimality conditions of a linear programming problem.
CO4:solve assignment and transportation problems.

Module1:Optimization	**5Hours**
Partitioning of matrices, Linear Programming Problems (LPP): definition and example, Formulation of LPP, Basic solution, Feasible solution and related definitions and results, Solution of LPP by Graphical method. Application of Linear Programming Problems.	
Module2:Covex sets and their properties	**10Hours**
Definitions of Point set, Hypersphere, Hyperplane, Open set, Closed set, convex combination, lines, Line segments. Convex set: definition, properties, related results and examples. Convex hull. Relation of convex set with feasible solutions.	
Module3: Simplex method	**20Hours**
Matrix representation of LPP. Slack, surplus and artificial variables. Simplex method for solving LPP. Two phase method, Big – M method. Duality in Linear programming. Dual Simplex method.	
Module4: Assignment Problems	**10Hours**
Assignment problem, mathematical formulation of Assignment problem. Hungarian method for solution of Assignment problem, Optimality in assignment problem, unbalanced assignment problems.	
Module 5:Transportation Problems	**15 Hours**
Transportation problems, Solution of Transportation problem: North-West Corner Rule, Lowest cost entry method, Unit – Cost Penalty method (Vogel's approximation method), Optimality test: the MODI method, Degeneracy in transportation method, Unbalanced transportation method.	
TotalLecturehours	**60hours**

TextBook(s)

1. Gupta, R.K., Operation Research, Krishna Prakashan Media Ltd.
2. Swarup, Kanti, Gupta, P.K. and Mohan, M., Operations Research, S. Chand and Co., 2010
3. Taha, H. A.,Operations Research:An Introduction, Pearson Education, 2019

ReferenceBooks

1. Bronson, Richard, Naadimuthu, Govindasami. Operations Research, Schaum Outlines Series,McGraw Hill Education, 2017.

CORE COURSES OFFERED BY DEPT. OF MATHEMATICS

BMA23323T	SPHERICAL TRIGONOMETRY & ASTRONOMY	L	T	P	C
		3	1	0	4

Pre-requisite: Trigonometry

Course Objectives:

- To investigate the tools find spherical trigonometric relationships and make comparisons to planar trigonometry.
- To gain knowledge of the similarities and differences of trigonometric properties of segments, angles, and triangles in spherical geometry.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: understand methods for measuring segment lengths and angles in spherical geometry

CO 2: analyse the laws of Sines and Cosines

CO3: analyse the differences of trigonometric properties of segments, angles, and triangles in spherical geometry

CO4: understand the concept of motion of stars

Module1: Spherical Triangle	**15Hours**
Spherical triangle, Polar Triangles and their properties, Sine and Cosine formulae, Sine-Cosine formulae, Napier's formula	
Module2: Celestial Sphere	**20Hours**
Definition, Annual motion of the sun, System of coordinates and their relation, Geocentric celestial sphere, Rising and setting of stars, Circumpolar stars, Signs of zodiac	
Module3: Atmospheric Refraction	**15Hours**
Laws of refraction, Refraction of a star near the Zenith, Differential equation for refraction, Simpson's hypothesis, Bradley's formula, Effect of refraction in any direction and of two neighbouring stars	
Module4: Eclipses	**10Hours**
Eclipses of the moon, Dip of horizon taking refraction into account, The position circle	
Total Lecture hours	**60hours**

Text Book(s)

1. Dubey S. K. D, Pandey D. S., Dwivedi B. D., A Text Book of Spherical Trigonometry and Spherical Astronomy, Swastik Distributors, 2018
2. Smart W. M., Textbook on Spherical Astronomy, Cambridge University Press, 1986

Reference Books

1. Singh B., Spherical Astronomy and Space Dynamics, Pragati Prakashan, 2009